Departement für Pferde
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Direktor: Prof. Dr. med. vet. Anton Fürst, Dipl. ECVS

Arbeit unter wissenschaftlicher Betreuung von
Dr. med. vet. Felix Theiss, Dipl. ECVS

A retrospective study of the prevalence of injuries to the suspensory ligament, digital flexor tendons and associated structures in a non-racehorse referral-hospital population

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vorgelegt von

Marc Trump

Tierarzt
aus Düren, Deutschland

genehmigt auf Antrag von

Prof. Dr. med. vet. Anton Fürst, Dipl. ECVS, Referent
Prof. em. Dr. med. vet. Hans Geyer, Korreferent

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1. Abstract

This study investigated the prevalence of injuries to the suspensory ligament (SL), the digital flexor tendons and associated structures in relation to the type of athletic use of the horse. The medical records of 1,527 horses referred to the Equine Department, University of Zurich, from 1992 to 2009 because of non-septic tendinitis, desmitis or tendovaginitis were reviewed. The majority of the horses in the study population were used for pleasure riding (23.3%), show jumping (20.4%) and dressage (10.5%). Eventing (3.4 %), driving (2.8%) and endurance horses (1.4%) were less common. The suspensory ligament was the most frequently affected structure in the overall study population (31.2%); the frequency of SL injuries was 41.6% in dressage horses, 28.6% in show jumpers and 28.1% in pleasure horses. The superficial digital flexor tendon was the most frequently affected structure in eventing horses (50%) and the digital flexor tendon sheath (27.9%) was the most commonly affected structure in driving horses.
Injured show jumpers ($p<0.001$), dressage ($p<0.001$) and eventing horses ($p=0.007$) were significantly younger than injured pleasure horses.
The type of athletic use of a horse has a direct impact on the prevalence of injuries to the suspensory ligament, flexor tendons and associated structures. This knowledge can be used to improve the veterinary care for horses with different athletic occupations.

2. Introduction

Injuries of tendons and ligaments belong to the most common injuries in equine athletes. These injuries have been shown to significantly impact the athletic performance and significantly increase morbidity and mortality rates in racehorses (1-4) as well as in horses performing in other sporting disciplines (5, 6). In the current body of literature, reports on the prevalence of different tendon and ligament injuries mainly focus on the racehorse population. In racehorses the superficial digital flexor tendon (SDFT) is the most commonly injured structure, followed by the SL. Tendon and ligament injuries in racehorses have predominantly been reported in the forelimbs rather than in the hindlimbs (3, 4, 7). It has been shown that anatomical structures of the musculoskeletal system are exposed to different loads depending on the horses' individual athletic use, it's breed and it's age (8). Therefore, data on the prevalence of tendon and ligament injuries acquired from a certain horse population, such as the racehorse population, may not be directly extrapolated to the non-racehorse population.

Currently there are few, contradictory anecdotal reports on the prevalence of tendon and ligament injuries in horses performing in various non-racing equestrian disciplines and unfortunately many of these reports have scientific limitations. Van den Belt *et al*. (9) ultrasonographically evaluated 101 Dutch Warmblood horses with tendon and ligament injuries. The most frequently injured structure in the forelimb was the SL (31%) and the SDFT (29%) followed by the accessory ligament of the deep digital flexor tendon (AL-DDFT) (17%). In the hind limb the SL (11%) was the most frequently injured structure. In this report the frequencies of injured structures was shown, but there was no specific information provided on the individual use of the horses in the studied population.

Gibson *et al*. (10), reported on the ultrasonographic diagnosis of soft tissue injuries in horses competing in different equestrian disciplines at the 2000 Olympic Games in Sydney, however the total number of horses reported on was only small. In this group the SL was most commonly affected in dressage horses (6/8 horses) and in show jumpers (9/15 horses). In eventing horses injuries of the SDFT were the most prevalent (28/47 horses) followed by injuries of the SL (18/47 horses).

Murray *et al*. (8), evaluated 1069 medical records of non-race horses with injuries of the musculoskeletal system, of which tendon and ligaments injuries were a small part. In this study the SL was the most commonly affected ligamentous structure in the pleasure riding, dressage, show jumping and eventing horse population. Despite the relative large number of horses included in the study, the number of horses per ligament or tendon injury site was relatively low and total numbers of cases were not given in this study. Regarding dressage horses another study using a questionnaire based design has been performed and found that, in contrast to Murray *et al*. injuries of the SL were only the second most frequent cause of lameness (11).

Relative to the current significance of tendon and ligament injuries in the non-racehorse population, there is sparse scientific data available on large numbers of horses performing in other sporting disciplines (12-18). Additionally, none of these studies further subdivide the injured tendineous and ligamentous structures into subunits and none of these studies include the evaluation of concurrent injuries to their close associated tenovaginal sheaths or ligaments. Thus the objective of this study was to report the prevalence and the exact intra structural location of SL, SDFT, deep digital flexor tendon (DDFT) and AL-DDFT injuries as well as injuries of their close associated structures (Digital flexor tendon sheath (DFTS), palmar/plantar annular ligament, distal sesamoidean ligaments (DSL), carpal sheath (CS) and tarsal sheaths (TS)), in different non-racing sporting disciplines. It was hypothesised that each sporting discipline has a different prevalence of SL, SDFT, DDFT and ALDDFT injuries as well as injuries of their close associated structures.

3. Material and Methods

Medical records of horses presented to the Equine Hospital, University of Zurich, Switzerland between 1992 to 2009 because of a first occasion injury of a tendon (SDFT, DDFT) or a ligament (SL, AL-DDFT, DSL and palmar/ annular ligaments) as well as cases diagnosed with tenovaginitis (CS, TS, DFTS), were reviewed. Additionally horses with biceps brachii tendonitis, gastrocnemius tendonitis (including injuries of the common calcaneal tendon), lateral/common digital extensor tendonitis and peroneus tertius tendonitis, primary PAL and lateral / medial digital flexor tendonitis and the tendonitis of the tibialis caudalis, were included in this study. Cases with traumatic lacerations, septic tendonitis or septic tenovaginitis were excluded from this study. Information recorded from each patient included signalement, type of use, affected limb, structures injured and location of the injury within the structure. The group of pleasure horses included horses exercised for recreational purposes in non-competitive equestrian disciplines.

To further specify the lesions of the different anatomical structures, the tendons and ligaments were subdivided into different sections and the sections were numbered. The digital flexor tendons were divided into 4 different sections: Section 1) At the level of the CS/ TS; Section

2) Between the CS/TS and the DFTS; Section 3) Within the DFTS; Section 4) DDFT lesions distal to the DFTS and lesions of the SDFT branches. Tendovaginitis cases were included in the tendon lesion-section 3 group for the respective tendon. The suspensory ligament was divided into 4 different sections: Origin of the SL; Section 1) Body of the SL; Section 2) Lateral and medial branches of the SL; Section 3) Insertion of the branches at the proximal sesamoidean bones. Proximal suspensory desmitis (PSD) was defined as cases positive to diagnostic anesthesia of the origin of the SL with additionally, either ultrasonographic, radiographic or scintigraphic changes at the origin of the SL.

Primary tenovaginitis cases (DFTS, CS and TS) were grouped separately and defined as cases with tendon sheath effusion and a positive response to intrathecal anesthesia without an ultrasonographically detectable tendon lesion. Digital flexor tenovaginits cases were divided into 2 groups depending on whether a palmar/plantar annular ligament desmitis (PAL-D) was present or not. A PAL-D was defined as a palmar/plantar annular ligament with a thickness of ≥2mm measured ultrasonographically. The distal sesamoidean ligaments (straight, oblique, cruciate, short) were grouped as DSL.
Results were converted into numeric data and tabulated in SPSS 20.0 (IBM, Zurich, Switzerland). The chi-square test for association was used to compare dependent frequencies. When dependent frequencies were smaller than five, a Fischer's exact test was used.

4. Results

4.1. Overall Study Population

1527 cases met the criteria for inclusion into the study. Of the study population horses were predominantly used for pleasure riding (23.3%), show jumping (20.4%) and dressage (10.5%). Less common were eventing horses (3.4%), driving horses (2.8%), endurance horses (1.4%) and others (10.3%). In 28.3%, the type of use was not recorded. Warmbloods (WB) (68.5%) were predominant in the overall population. Other breeds were ponies/Icelandic horses (10.1%), Thoroughbreds (6.2%), Arabian horses (4.6%) and others (10.6%). (Absolute numbers of horses, their respective use, breed and gender are summarized in table 1). There were significantly more geldings amongst the dressage horses (71.4%) compared to the non-dressage horses (56.5%) ($p < 0.001$). Otherwise the sex distribution was not significantly different amongst the groups of use. Show jumpers ($p<0.001$), dressage horses ($p<0.001$) and eventers ($p=0.007$) were significantly younger compared to pleasure horses (Table 3). Otherwise there were no significant differences between the ages of the different uses.
The comparative risk for a forelimb to be affected compared to a hindlimb was 3.0 times higher in eventing horses, 2.61 times higher in show jumpers, 1.78 times higher in dressage horses, 1.72 times higher in pleasure horses, 1.39 times higher in driving horses and 1.2 times higher in endurance horses. Table 2 summarises the absolute numbers of all horses with tendon and ligament injuries, the respective limb and respective type of use.

For the overall study population the most commonly affected structure was the SL (31.2%). Overall a SL injury was diagnosed in 56.9% of forelimbs and 43.1% of hindlimbs. PSD (38.9% of cases) occurred in 48.1% of the forelimbs and 51.9% of the hindlimbs. Desmitis of the SL body (section 1) occurred in 13.2% of cases (86.8% of the forelimbs and 13.2% of the hindlimbs). Desmitis of the SL branches (section 2) occurred in 38.7% of the cases, of which 53.1% were forelimbs and 46.9% were hindlimbs. When present, the lateral branch was significantly more often affected in the forelimbs compared to the medial branch in the

hindlimbs (p= 0.002). An insertional desmopathy (section 3) was diagnosed in 9.2% of cases, affecting the forelimbs (63.6%) more often than the hindlimbs (36.4%). Table 3 shows a complete summary of the horses` age separated by their respective use and by the location of the injury. Horses with SL desmitis had a mean age of 10.9 years (median 11.0 years). Horses suffering from PSD (mean 10.4 years; median 10.0 years) were significantly younger compared to horses suffering from injuries of the SDFT (mean 12.5 years; median 12 years; ($p<0.001$)) and compared to horses suffering from AL-DDFT injuries (mean 13.1 years; median 13.0 years; ($p<0.001$)).

The second most commonly affected structure was the SDFT (22.2%). A SDF tendonitis was present in 90.3% of the forelimbs and in 9.7% of the hindlimbs. Lesions in SDFT section 1 occurred in 17.7% of the cases, lesions in section 2 in 65.4% of the cases and lesions in section 3 in 15.6% of the cases. SDFT lesions in section 1 only affected the forelimbs and were accompanied by secondary effusion of the carpal sheath in 50% of the cases. Lesions in section 3 affected 58.5% forelimbs and 41.5% hindlimbs. Lesions of the SDFT at section 3 caused secondary effusion in 77.4% (n=41) of the DFTS. Secondary effusion was present in 53.7% of the forelimbs and 46.3% of the hindlimbs. PAL occurred in 47.2% of section 3 SDFT lesions (n=25) and affected in 56.0% the frontlegs and in 44.0% of the hindlegs. Horses with lesions of the SDFT had a mean age of 12.5 years (median 12.0 years). Horses suffering from SDF tendonitis were significantly older than horses suffering from DDF tendonitis (mean 10.9 years; median 11.0 years; ($p<0.05$)). Moreover horses with section 1 SDFT lesions (mean 17.2 years; median 17.0 years) were significantly older than horses with lesions distal to section 1 (mean 11.6; median 11.0 years; ($p<0.001$)).

Primary tenovaginitis of the DFTS was diagnosed in 19.7% of all horses, of which 44.5% were forelimbs and 55.5% were hindlimbs. 55% of all primary tenovaginitis cases of the DFTS were diagnosed with PAL-D. The hindlimbs (63.5%) were significantly more often affected by PAL-D than the forelimbs (36.5%) ($p<0.001$). The mean age of horses suffering from tenovaginitis of the DFTS was 12.4 years (median 12.0 years).

Desmitis of the AL-DDFT was diagnosed in 12.5% of cases of which 98.4% were forelimbs and (1.6%) were hindlimbs. Horses suffering from AL-DDFT desmitis had a mean age of 13.1 years (median 13.0 years) and were significantly older compared to horses with SL desmitis ($p<0.001$) and horses with lesions of the DDFT ($p<0.001$).

Tendonitis of the DDFT was present in 6.1% of horses of which 48.4% were front limbs and 51.6% were hindlimbs. Lesions in section 1 occurred in 4.5% of the cases, lesions in section 2 occurred in 20.4% of the cases, lesions in section 3 in 60.2% of the cases and lesions in section 4 in 15.0% of the cases. Lesions of section 3 affected 32.1% forelimbs and 67.9% hindlimbs and occurred significantly more often in the hindlimbs than in the forelimbs ($p<0.001$). Lesions of the DDFT in section 3 caused secondary effusion of the DFTS in 83.9% (n=47) of the cases and affected in 25.5% the frontlimbs and in 74.5% the hindlimbs. PAL due to secondary effusion occurred in 37.5% (n=21) and affected in 28.6% the frontlimbs and in 71.4% the hindlegs. Horses suffering from tendonitis of the DDFT had a mean age of 10.9 years (median 11.0 years). Desmitis of the DSL occurred in 3.1% of all cases and affected the forelimbs in 62.5% and the hindlimbs in 37.5%. The mean age of horses with DSL desmitis was 10.7 years (median 10.0).

Results of horses with biceps brachii tendonitis, gastrocnemius tendonitis (including injuries of the common calcaneal tendon), lateral/common digital extensor tendonitis and peroneus

tertius tendonitis, primary PAL and lateral / medial digital flexor tendonitis and the tendonitis of the tibialis caudalis are summarised in table 2.

4.2. Pleasure Riding

28.1% of horses used for pleasure riding were diagnosed with SL desmitis. Overall this was the most common diagnosis in this group of use and affected 57% of all forelimbs and 43% of all hindlimbs in this group of use (Fig. 1). Desmitis of the body or the branches of the SL was more often diagnosed in the forelimbs, whereas PSD was fairly equally diagnosed in fore- (54.1%) and hindlimbs (45.9%).

Primary tenovaginitis was diagnosed in 22.8% of cases in this use group, of which 61.7% had accompanying PAL-D. PAL-D was more commonly diagnosed in the hindlimbs (73.5%) than in the forelimbs (26.5%). 22.5% of cases suffered from SDFT lesions (87.5% forelimbs and 12.5 % hindlimbs). A proximal tendonitis of the SDFT (section 1) was present in 22.4%. Section 2 was affected in 51.3 % and section 3 in 26.3% of cases. There were no horses used for pleasure riding with lesions in section 4. Pleasure horses with SDFT tendonitis (mean 15.9 years, median 16.0 years) were significantly older then the mean age of the overall pleasure horse group (mean 13.4 years, median 13.0 years; $p<0.05$). This was especially true for horses with section 1 lesions (mean 19.6 years; median 19.0 years; $p<0.001$) compared to lesions in the other SDFT sections. Tendonitis of the SDFT within the DFTS (section 3) was significantly more common in pleasure horses than in show jumpers ($p=0.003$) or dressage horses ($p=0.002$).

DDF tendonitis was diagnosed in 5.6% of cases, the AL-DDFT was affected in 14% of cases and DSL was affected in 3.1% of cases. Further details are depicted in tables 2 and 3. Considering fore- and hindlimbs independently, SDF tendonitis (31.3 %) was the dominating diagnosis of pleasure horses in the forelimb (Fig. 2) and primary tenovaginitis of the DFTS (43.2%) was the most common injury in the hindlimb (Fig. 3).

4.3. Jumping

In show jumpers the most commonly affected structure was the SL (28.6%) (Fig. 4). Injury of the SL branches (section 3) was diagnosed in 53.3% of the fore- and 46.7% of the hindlimbs. The lateral SL branch was more often affected in the forelimb (81.8%) and the medial one in the hindlimb (64.7%). This difference was statistically significant ($p=0.008$). Desmitis of the body of the SL (section 1) was most commonly diagnosed in the forelimbs (92.9%), in contrast PSD was most commonly diagnosed in the hindlimbs (66.7%). The mean and median age of horses suffering from SL desmitis was 10.0 years. In show jumpers, section 1 SL lesions were significantly more common compared to dressage horses ($p<0.05$).

The SDFT was the second most commonly affected structure in this group (23.8%). The front limbs (93.2%) were more often injured than the hindlimbs (6.8%), with section 2 accounting for 71% of all lesions. A section 1 lesion was diagnosed in 23.2 % of the cases, a section 3 lesion in 1.9% of the cases and a section 4 lesion in 0.1 % of the cases. The mean and median age for jumping horses suffering from SDFT injuries was 11.5 years. The prevalence of SDF tendonitis in show jumpers was significantly ($p=0.024$) higher compared to dressage horses.

Primary tenovaginitis of the DFTS occurred in 20.9% of all show jumpers (63.1% of the forelimbs and 36.9% of the hindlimbs). In 49.2% of cases the DFTS tenovaginitis was accompanied by PAL-D. Show jumpers with DFTS injury had a mean age of 11.8 years, median 11.0 years. Primary tenovaginitis of the DFTS in the forelimb was significantly more frequent in show jumpers compared to pleasure horses ($p<0.001$) and driving horses ($p=0.014$). Show jumpers (mean age 11.6, median 11.0), suffering from PAL-D were significantly younger than pleasure horses (mean age 13.4, median 14.0, $p<0.05$) and PAL-D was also significantly more common in the forelimbs of show jumpers compared to pleasure horses ($p=0.013$).

Overall show jumpers suffering from SDFT tendonitis ($p<0.001$), DFTS tenovaginits ($p=0.034$), SL desmitis in general ($p=0.014$) and PSD ($p=0.045$) were significantly younger than pleasure horses. Injury to the AL-DDFT was diagnosed in 14.8% of the cases, DDF tendonitis in 8% of the cases and DSL injury in 3.2% of the cases. Details for these injuries are depicted in tables 2 and 3. Comparing fore- and hindlimbs separately, SDF tendonitis (30.7%) was most prevalent in the forelimbs (Fig. 5) and SL desmitis (48.8%) in the hindlimbs (Fig. 6) when horses were used for show jumping.

4.4. Dressage

In dressage horses the SL was the most commonly injured structure (55.2% of the forelimbs and 46.8% of the hindlimbs) (Fig. 7). The origin of the SL (PSD) was the most frequent location of SL injuries in this group of horses (41.8% of all SL injuries, 55.2% of the forelimbs and 44.8% of the hindlimbs). Section 1 lesions were diagnosed in 4.5% of cases, section 2 lesions in 44.8% of the cases and section 3 lesions in 8.9% of the cases. Section 2 lesions were evenly distributed between fore- and hindlimbs, but the lateral SL branch was significantly more often affected in the forelimbs (73.3%) and the medial SL branch in the hindlimbs (83.3%) ($p<0.05$). The mean age of dressage horses suffering from SL desmitis was 10.9 years (median 12.0 years). In dressage horses, the SL was significantly more frequently affected than in show jumpers ($p=0.004$) and in pleasure horses ($p=0.002$).

The second most prevalent structure injured in this group of horses was the DFTS (18.6%). Primary tenovaginitis was almost equally prevalent in the fore- (55.3%) and the hindlimbs (46.7%). In 40% of the tenovaginitis cases accompanying PAL-D was diagnosed. The mean age of horses suffering from tenovaginits of the DFTS was 11.4 years (median 12.0 years). The SDFT was injured in 14.9% of the dressage horses. 91.7% of the forelimbs and 8.3% of the hindlimbs were affected. In dressage horses section 1 was injured in 8% of the cases and section 2 in (%)of the cases. No lesions could be identified in sections 3 or 4 of the SDFT. Horses suffering from SDFT tendonitis had a mean and median age of 13.0 years. Dressage horses with a proximal SDFT injury (section 1) were significantly older ($p=0.001$)(mean age 15.9, median 16.0) than the mean age of the overall dressage horse group (mean age 11.3, median 12.0).

AL-DDFT desmitis was diagnosed in 12.4% of the cases, DDF tendonitis in 5% of the cases and DSL desmitis in 2.5% of dressage horse cases. Details of these injured structures are depicted in tables 2 and 3. Considering fore- and hindlimbs separately, desmitis of the SL was the most frequent diagnosis in the fore- (Fig. 8) and the hindlimbs (Fig. 9) of dressage horses.

4.5. Eventing

The SDFT was the most commonly affected structure in the group of eventing horses (50%) (Fig. 10). The forelimbs were affected in 92.3% of the cases and the hindlimbs in 7.3% of the cases. Section 2 of the SDFT was affected in 84.7% of the cases, section 3 in 11.5% of the cases and section 4 in 3.8% of the cases. Section 1 of the SDFT was never affected in this use group. The mean age of eventing horses suffering from SDFT lesions was 12.0 years (median 11.0 years). In eventers tendonitis of the SDFT was significantly more common than in show jumpers ($p<0.001$), dressage horses ($p<0.001$), pleasure horses ($p<0.001$) and driving horses ($p=0.007$).

In 26.9% of the cases a SL injury could be diagnosed. PSD was diagnosed in 35.7% and the hindlimbs were affected in 80% of the cases and in the frontlimbs in 20% of the cases. Section 1 SL lesions were diagnosed in14.3% cases, section 2 lesions in 35.7% cases and section 3 lesions in 14.3% cases. Eventing horses with SL injuries had a mean age of 10.2 years (median 10.0 years).

Desmitis of the AL-DDFT, was the third most common diagnosis. It was present in 7.7% of the cases and affected solely the forelimbs. These affected horses had a mean and median age of 10.0 years. The DFTS was affected in 5.8% of the cases, the DDFT was affected in 3.8% of the cases and the DSL in 3.8% of the cases. All details of these injuries are depicted in tables 2 and 3. A tendonitis of the SDFT was the most common diagnosis in the forelimbs (Fig. 11), whereas desmitis of the SL was most common in the hindlimbs of eventing horses (Fig. 12). Eventing horses with a tenovaginitis of the DFTS (mean age 16.3, median 16.0), especially those with a PAL-D (mean age 17.5, median 17.5) were significantly older ($p<0.05$) than the mean age of the eventing horses (mean 11.5, median 11.0).

4.6. Driving

Driving horses were most frequently presented with a tenovaginitis of the DFTS (27.9%) (Fig. 13) and in 58.3% of the cases the tenovaginitis was accompanied by PAL-D. PAL-D occurred mainly in the hindlimbs (85.7%) of cases and very rarely in the forelimbs (4.3%) of cases. The mean age of driving horses suffering from tenovaginitis of the DFTS was 11.7 years (median 12.0 years). In contrast to show jumpers, where DFTS tenovaginitis dominates in the forelimbs, in driving horses the hindlimbs were significantly more often affected by DFTS tenovaginitis (75%) ($p=0.014$).

Desmitis of the SL was present in 25.6% of the cases of which 90.1% of the SL lesions were diagnosed in the forelimbs and 9.9% in the hindlimbs. The specific location of lesion section and the respective injured limb is summarised in table 2. Driving horses with SL desmitis had a mean age of 11.6 years (median 9.0 years). Driving horses with desmitis of the body of the SL (section 1) were significantly younger ($p=0.024$, mean 7.0 years, median 7.0 years) than the mean age of the entire driving horse group (mean 12.4 years, median 12.0 years).

Tendonitis of the SDFT (23.3% of the cases) was located in the forelimbs in 70% of the cases and in the hindlimbs in 30% of the cases. No cases with lesions diagnosed in section 1 were present. Lesions in section 2 were solely diagnosed in the forelimbs. Lesions in section 3 were

present in 25% of the forelimbs and 75% of the hindlimbs. All cases of hindlimb SDF tendonitis had injuries located within the DFTS (section 3).

The mean age of driving horses with lesions of the SDFT was 13.9 years, median 15 years. Lesions of the DDFT, AL-DDFT und DSL were each diagnosed in 7% of the cases. Details of these cases are shown in tables 2 and 3. Considering the forelimbs, desmitis of the SL was most frequent injury (Fig. 14), whereas primary tenovaginitis of the DFTS was the dominating diagnosis in the hindlimbs (Fig. 15). In contrast to show jumpers, the hindlegs in driving horses with DFTS tenovaginitis were significantly more commonly affected (75%) ($p=0.014$).

4.7. Endurance

The group of endurance horses was limited to 22 cases. The SL (31.8%) and the DFTS (31.8%) were the most frequently injured structures (Fig. 16). In 71.4% of endurance horses suffering from SL desmitis the forelimbs were affected and in 28.6% of the cases the hindlimbs were affected. Distribution of specifically injured sections of the SL and the respective limbs are depicted in table 2. The mean age of endurance horses suffering from SL lesions was 11.9 years (median 13.0 years).

Tenovaginitis of the DFTS (31.8% of all cases) occurred in 28.6% of the forelimbs and 71.4% of the hindlimbs. Accompanying PAL-D was diagnosed in 1 case in the forelimb (20%) and in 4 cases in the hindlimbs (80%). The mean age of endurance horses suffering from tenovaginits of the DFTS was 12.4 years (median 14.0 years). DDFT lesions occurred solely in 2 cases (9.1%). One hindlimb and one forelimb was affected and lesions were located in section 3 of the DDFT. The mean age in these horses was 12.0 years (median 12.00 years). Details of SDFT, DSL and AL-DDFT injuries are depicted in tables 2 and 3. Considering the fore- and hindlimbs separately, desmitis of the SL was the most frequent diagnosis of the forelimbs (Fig. 17), whereas primary tenovaginitis of the DFTS was the most frequent diagnosis in the hindlimb (Fig. 18). There was no difference in the prevalence of affected fore- or hindlimbs between Warmbloods and Thoroughbreds in endurance horses.

5. Discussion

Musculoskeletal injuries and amongst those, tendon and ligament injuries have been shown to be of major importance, (2, 3, 19-21) not only in the racehorse population (5, 8, 11). Even within the race horse industry differences exist in the incidence of tendon and ligament injuries as well as whether a fore- or a hind limb is affected (2, 3, 9, 19, 21-23). In the literature there is restricted availability of data in non-race horses, limiting the findings to a small and confined non-racehorse population. The data of this study helps to complete scientific data of tendon, tendon associated structures and ligament injuries in non-racehorses and clearly showed that different types of use lead to different incidences of tendon and ligament injuries. In Thoroughbred race horses frontlimbs are 4-5 times more commonly injured than hindlimbs (2). This ratio is much higher than the one obtained in the different types of non-racing disciplines in this study. This difference may be explained by a lower pace and by a larger amount of trot and walk in the workload of these non-racing horses. Interestingly eventers and show jumpers showed the highest ratio of fore limb injuries in this

study. These are two types of equestrian sports, in which the main workload is in gallop and landing after jumps exerts large forces on the structures of the frontlegs. In dressage horses, the center of gravity of the horse and rider is placed further caudally, leading to larger forces acting on their hind limbs. In this discipline only a part of the workload is canter, thus the ratio of front- and hindlegs affected is shifted towards the hind legs. In driving horses, pulling of a carriage may be a reason for the larger ratio of hind limbs affected.
Findings in endurance horses have to be interpreted with caution due to the low numbers in this group. The nearly equal ratio between front- and hindlegs involvement may be caused by the fact, that most endurance horses were Arabian horses. Arabian horses are a breed with a lower body weight compared to the rest of the study population. In addition the lower average speed in canter, necessary to accomplish longer distances in this sporting discipline, may have led to reduced peak loads in the energy storing of tendons in the fore limbs and thereby to this distribution pattern. Results of this study are in contrast to the study by van den Belt *et al*. (9), which found a ratio of 4:1 for frontleg involvement in 101 Dutch Warmblood horses used for pleasure riding up to high level competition. Unfortunately the designated type of use of the horses in van den Belts study was not more specifically defined.
In this study the sex distribution was equal between the different disciplines apart from the dressage horse group. In this group significantly more geldings were present, which is in agreement with the study of Walters *et al*. and may represent the fact that, generally geldings are more suitable for this type of sport, especially at higher levels (24).

5.1. Pleasure Riding

The group of pleasure horses is probably the most heterogeneous group in this study. This group is composed of ex-professional sport horses of different disciplines, which may have been retired. Despite of this, these horses might be subjected to daily work. At the same time, pleasure horses were significantly older than show jumpers, dressage horses and eventers. Furthermore horses with tendonitis of the SDFT were older (mean age 15.9 years) than the average of this group (mean 13.0 years). Even though athletic demands of pleasure horses may be minor compared to other disciplines, the high prevalence of injuries of the SDFT and SL may point out the importance of the energy storing function of these tendons for the overall locomotion of the horse. In addition the susceptibility for the accumulation of age and exercise related degenerative changes of the SDFT and the SL (2, 3, 19-21) may, at least in part, be responsible for the high prevalence of SL and SDFT lesions in this group.

In support of pre-existing degeneration, horses with severe lesions during ultrasonographical evaluation were significantly older than horses with only mild lesion characteristics (data not shown). Age and exercise related degenerative changes within the SDFT have mainly been shown associated with the metacarpal region of the SDFT (21). Interestingly horses with proximal (section 1) SDFT tendonitis had an average age of 19.6 years and were significantly older than the average age of horses with tendonitis of the SDFT in the overall group. This was also true in show jumpers and dressage horses with proximal tendonitis of the SDFT. Our observations are in accordance with a small case series reported by Chesen *et al*. (22), in which horses with proximal SDFT tendonitis had a mean age of 18 years and were significantly older than those with mid-metacarpal SDFT tendonitis. In the context of age and exercise related degenerative changes, the proximal SDFT, close to its musculo-tendineous junction may be at more risk of injury in older Warmblood horses.

The proportion of ponies and Islandic horses was the largest in the pleasure horse group, leading to an increase in frequency of tenovaginits of the DFTS, especially in the hind limbs and in conjunction with PAL-D. As only ultrasound was used in this study to differentiate between section 3 tendonitis and primary tenovaginitis of the DFTS, some cases of primary tenovaginitis may have been misinterpreted. It has been shown that some longitudinal tears of the SDFT and the DDFT or injuries of the manica flexoria are only evident on MRI or during tenovaginoscopic evaluation (25-27). However, the high incidence of tenovaginitis of the DFTS in ponies, especially in the hind limbs and along with a PAL-D is in agreement with the current literature (28, 29).

5.2. Jumping

Even though show jumping needs basic dressage training, daily work may simply be characterised by canter at different speeds und jumping over fences. Therefore it may not be surprising and concurs with the literature, that the major energy storing structures such as the SL and the SDFT were the structures the most commonly affected (8, 10, 30). Body weight and speed of canter between obstacles (8) as well as training or competition surfaces may be seen as risk factors, similar to the race horse population (31). The push off places large forces on the hind limbs, especially as extension of the hip leads to further hyperextension of the metatarsophalangeal joint (MTPJ) and thereby to further storage of elastic strain energy within the tendons (32).

Fore limbs are loaded asymmetrically at landing. The leading limb is placed at a later time point, at a more forward position and has a longer stance phase than the trailing limb (33). Therefore the trailing limb exhibits larger peak flexor joint moments of the coffin and the fetlock joint (34) and thereby loading of the SDFT and the SL, which primarily resist vertical limb loading, is higher (33). High strain rates, as seen during push-off and landing, shift the stress-strain curve to the left (35). The energy storing tendons and ligaments exhibit a stiffer response to load and thereby the yield point is reached earlier (36). The higher prevalence of SDF tendonitis in the front compared to SL desmitis in the front may be explained by the fact that, even as peak forces at landing are higher in the SL than in the SDFT, the relative loading of the tendons (landing force compared with failure force) is higher in the SDFT. Furthermore fence height does substantially influence SDFT forces, whereas it hardly influences forces on the SL (33).

The SL in jumping horses was the most common injured structure, taking fore- and hind limbs together and may be due to fatigue of the flexor tendons in the fore limbs (33) and due to additional hyperextension of the MTPJ when the hip extends during the push-off (32). Lesions of the SL body (section 1) were significantly more common in jumping horses, compared to dressage horses. Additionally, there was a strong trend ($p=0.051$), that jumping horses suffered from PSD more often in the hind limbs compared to pleasure and dressage horses. To our knowledge there is no study examining the load distribution pattern in the hind limb SL during the push-off phase in jumping horses. At least for SL body lesions, so far only described in race horses that jump over fences (steeplechase) (37), the lower elasticity of the body, compared to the branches (38), may be an explanation for the high incidence. The fact that in the fore limbs the lateral branch of the SL was significantly more commonly affected than the medial one, may be explained by additional centrifugal forces acting on the trailing limb during landing, but need further investigation. The higher incidence of medial branch involvement in the hind limbs, may at least in part, be explained by a wider stance of both

hind limbs and thereby larger forces acting on the medial branches during the push off. Possible anatomical differences between the lateral and the medial branches of the SL in the fore- and in the hind limbs, may play an additional role, but to our knowledge have not been investigated yet.

As only ultrasound was used to diagnose primary tenovaginitis in this study, the relative large numbers have to be interpreted with caution, because section 3 SDFT or DDFT injuries or tearing of the manica flexoria may have been overlooked. But still, repetitive trauma due to hyperextension of the fetlock joint at the push off in the hind limbs and especially the landing in the fore limbs may be the reason for the significant differences in occurrence of DFTS tenovaginitis compared to pleasure and driving horses.

Desmitis of the AL-DDFT is reported to be common in athletic horses (33) for example jumping horses (30). As peak forces at landing are lower in the AL-DDFT than in the SL and the SDFT, as relative loading of the DDFT is lower than in the SL and especially in the SDFT and as fence height does not influence strain in the AL-DDFT, other factors like fatigue of the SDFT and DDFT (33) might influence the prevalence of AL-DDFT injury. Despite this, the DDFT and the AL-DDFT contribute to the generation of a push off force in final stance after landing, whereas the SDFT and the SL resist vertical limb loading (33). The average age of horses suffering from AL-DDFT desmitis was significantly higher compared to horses with SL and DDFT lesions. This agrees with the study of Becker *et al*. and is thought to be associated with age related degenerative changes, that play a mayor role in the pathogenesis of injuries of the AL-DDFT (39).

5.3. Dressage

Dressage horses were significantly more often affected by SL desmitis compared to jumping horses and pleasure horses. Comparable results have been published by Murray *et al*. (8). Dressage horses, compared to other disciplines, have a high interval of trot and pace is commonly changed. Since the SL is maximally loaded due to maximal extension of the MCPJ/MTPJ, when during trot only one fore and hind limb is on the ground, the risk of SL desmitis may increase (40-42). As shown by Riemersma *et al*., the mean maximal strain and mean maximal load in walk and trot is higher in the SL compared to the SDFT.

Dressage horses are generally taller (43), heavier (8) and have more ground coverage than horses of other disciplines, which may further increase the hyperextension of the fetlock joints. Additionally muscle dysfunction and fatigue may increase the risk for SL injury, since the proximal part of the SL consists of a varying amount of muscle fibers (38). Muscle fatigue of the SDFT and DDFT, as has been shown in Standardbred trotters and in jumping horses and may lead to a further hyperextension of the MCPJ/MTPJ and lead to further strain in the SL (33, 44).

Injury of the SL occurred predominately in the proximal part of the SL and in the SL branches. These results confirm the previously described distribution of SL lesions (37). In contrast to show jumpers and racehorses, in which the peak load and the strain rate is higher, dressage horses show lower peak loads which may cause damage to the more elastic SL branches (38). In agreement with the literature, the SL in the hind limbs of dressage horses was significantly more often injured compared to pleasure horses (8). Dressage horses, especially at higher levels, have to carry more weight on their hind limbs, which further

increases the hyperextension of the MTPJ, especially in extended trot (41). Like in show jumpers, the lateral branch of the SL was significantly more often affected in the fore limbs, whereas the medial branch was significantly more often affected in the hind limbs. Sideways gaits in dressage horses, limb obliquity and asymmetric weight bearing due to bad conformation of the hoof (45, 46), may lead to stress on the branches of the SL. Despite this, a high scoring trot is characterised by diagonal placement of the hind limbs (47), which may predispose to injury of the medial SL branch. As speculated in jumping horses, anatomical differences between the SL branches may play an important role.

In dressage horses the second most commonly affected structure was the DFTS. This may result from repetitive low-grade trauma due to hyperextension of the MCPJ and MTPJ (48). As only ultrasound was used in this study to differentiate between section 3 tendonitis and primary tenovaginitis of the DFTS, some cases of primary tenovaginitis may have been misinterpreted. The number of dressage horses suffering from SDF tendonitis was quite low (n=24), but SDF tendonitis was still the third most common problem. In dressage horses with tendonitis of the SDFT, as well as in horses with AL-DDFT desmitis, the average age was significantly higher compared to horses with DDFT and SL lesions. Therefore, accumulation of age and exercise related degenerative changes may play a major role in disciplines, in which low peak forces occur (compare to pleasure horses) (11, 49-52) and in disciplines that horses are used up to a higher age.

5.4. Eventing

Eventing combines disciplines such as dressage, jumping and additionally has a cross-country phase with a high number of jumps and a far distance the horses have to cover at high speed. The two most commonly affected structures in this group of horses were the SDFT (50%) and the SL (26.9%). These results concus with other studies (8, 14, 53), except for the fact, that in the present study, the number of SDFT injuries was higher. The relative loading of the SDFT in the trailing limb at landing (33) and its operation close to its functional limit at gallop in the cross country phase, predisposes this tendon to injury in this discipline (14).

Similar to race horses (3, 7) and show jumpers, the SL was the second most commonly affected structure. The energy storing function of the SL, increased loading of the SL due to fatigue of the SDFT and DDFT at landing (33) or fatigue of the SL due to running long distances at high speed predispose this ligament to injury.
In the hind limbs, the SL was most commonly affected, because on one hand, eventing horses have additional hyperextension of the MTPJ when the hip extends during the push off as in jumping horses (see jumping horses) and on the other hand, similar to dressage horses, they have to carry more weight on their hindlimbs, which further increases the hyperextension of the MTPJ, especially in the extended trot (see dressage horses).

Hyperextension of the MCPJ at landing (as discussed earlier) and high speed in the cross-country phase predisposes the SDFT to injury (14). Since at high speed canter the SDFT operates close to its functional limit (54), the SDFT ruptures earlier compared to the SL, because of the lower yield point compared to the SL (46) and the yield point is further decreased by increasing speed due to increasing strain rate (36).

In agreement to the literature (14) the AL-DDFT was the third most common site of injury in eventers, even though it was overall a relatively rare diagnosis (7.7%) in this study. As in

jumping horses, the AL-DDFT contributes to the push-off force in the final stance of landing. It has been shown, that fiber failure in the AL-DDFT in older horses developed at 50% of the strain shown to cause fiber failure in younger horses (39). This is supported by the results of the present study, eventers were significantly younger compared to pleasure horses and therefore the desmitis of the AL-DDFT was less commonly diagnosed in eventing horses compared to pleasure horses.

5.5. Driving

Driving horses combine different abilities of other disciplines with the exception that they have to pull a carriage. Competition horses have to complete a dressage test, a marathon where they have to cover large distances, intervals at high, speed gallop, fast gait changes and rapid acceleration and deceleration. In the cone driving part, beside suppleness and concentration, fast acceleration and deceleration as well as high speed intervals are demanded. The weight of the carriage changes the kinematics of the different gaits in these horses. The stride length and the overreach distance are significantly smaller and the fetlock extension in the hind limbs is increased (55, 56). This increase in hyperextension of the MTPJ and the hyperextension of the PIPJ during the early phase of propulsion may be the cause for repetitive trauma to the DFTS of the pelvic limb and as a consequence the high incidence of tenovaginitis of the DFTS in this group. As mentioned earlier, in most cases ultrasound was the only examination modality used and therefore, at least in some of the cases, a causative tendon lesion or injury of the manica flexoria may have been overlooked. The fact that all SDFT lesions in the hind limbs were located within the DFTS raises the risk, that some of them may have been overlooked and misinterpreted as primary tenovaginitis.

The high incidence of a desmitis of the SL, especially of the SL branches, and tendonitis of the SDFT in this type of use was mainly caused by their common involvement in the fore limbs. Again, the change in kinematics through the pull of a carriage, leading to a significant increase in fetlock extension also in the front limbs (55, 56). Also the inert mass of the carriage during deceleration and the tendency of driving horses to generally shift their weight to a lesser extent to the hind limbs may lead to an additional increase in hyperextension of the MCPJ and thereby to larger forces acting on the SL and the SDFT. As forces necessary for acceleration of the carriage are at least in part also generated within the fore limbs, hyperextension of the MCPJ and PIPJ and forces acting on the SDFT may additionally be increased during the early phase of propulsion. The effort to accelerate the carriage, predominantly generated by the hind limbs and thereby forces generated within the SDFT and the DDFT during propulsion may explain their common involvement in the hind limbs. Interestingly only section 3 lesions were noticed in the SDFT in the hind limbs whereas section 2 lesions were predominantly seen in the fore limbs. The pronounced hyperextension of the fetlock joint in the hind limbs and thereby larger strains acting on the SDFT, but maybe also larger compressive forces acting on the SDFT as it curves around the hyperextended fetlock joint may be a possible explanation for this distribution pattern.

5.6. Endurance

Endurance is a popular and still growing discipline in many countries. Despite this there is unexpected little scientific data available on clinical issues, particularly orthopedic injuries in

these horses (57). This is especially surprising, as lameness has been proven to be the most common cause for elimination during competition (58-62).

The SL is reported to be commonly involved in endurance horses (13, 63, 64), but this information resembles personal experience of the authors and is not evidence based data. Even more unspecific is the observation of proximal metacarpal pain during the vet gates (13), where involvement of the SL is just one of the possible differential diagnoses. Even though the number of endurance horses was limited in the present study, the high numbers of cases with SL involvement, especially in the fore limbs, reinforces the findings of the existing literature.

Unexpected to us, a tenovaginitis of the DFTS was the most common diagnosis in the hind limbs and as common as SL desmitis in the overall study population of endurance horses. Arabian horses and Arabian cross breeds are commonly used for endurance (13). This was also true for the present study, where two-thirds of cases were Arabian horses, a horse breed, with a comparable low body weight. The long distance effort, accomplished in trot, gallop and walk carries the risk of muscle fatigue, especially of the muscles of the SDFT and DDFT. The decrease in fetlock support by the SDFT and DDFT increases the forces acting on the SL. Furthermore the resulting increase in fetlock hyperextension may lead to even larger strains acting on the SL. It may also be the increase in hyperextension of the fetlock joint in combination with propulsive forces which may have caused the high incidence of DFTS tenovaginitis in the hind limbs. Again limitations of the diagnosis of primary tenovaginitis of the DFTS confirmed only by ultrasonographic examination have to be kept in mind. Some of the studies on endurance horses available did show an association between distance of the ride and elimination due to lameness (59, 62), whereas others did not (61). As causes of lameness were not reported in either of these studies further work is needed to prove the relation between distance, fatigue and risk of SL or DFTS injuries in endurance horses.

5.7. Limitations

Being a retrospective study, not all data sheets of every case were complete. If type of use of the horse was not documented, the case could not be allocated to one of the use groups and thereby allocated to the group “other”. Due to this, some of the informative value of these cases was lost. The number of cases in the group of driving and endurance horses were comparably low, necessitating careful interpretation of the results of theses groups. Cases were from a referral equine hospital and therefore preselected. As MRI was not available throughout the whole study period only cases with ultrasonographic findings were included. Concurrently some cases of primary tenovaginitis of the tendon sheets may have been misinterpreted.

5.8. Conclusion

The type of use of a horse and thereby differences in strains placed on certain structures of the locomotory system, exerts a direct impact on the prevalence of specific tendon, tendon associated structures and ligament injuries. Even within some structures, differences in the distribution pattern of lesions exist between the different disciplines. Beside dressage horses, tendineous structures most commonly affected differed between the fore and the hind limbs.

Disciplines in which a larger portion of the work load is done in gallop or canter and in which horses jump over fences the SDFT of the fore limbs and the SL and the DFTS in the hind limbs seem to be most at risk. In dressage horses the difference in demands, especially lower gaits and a selection for heavy horses with larger ground coverage leads to a larger involvement of the SL in the fore limbs. In driving horses pulling a carriage changes the kinematics of the different gaits and results in common tenovaginitis of the DFTS. The use of horses in the disciplines jumping, dressage and eventing, leads to orthopedic soft tissue injuries at a younger age compared to horses used for pleasure riding.

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7. Appendix

7.1. Figures

7.1.1. Pleasure Riding

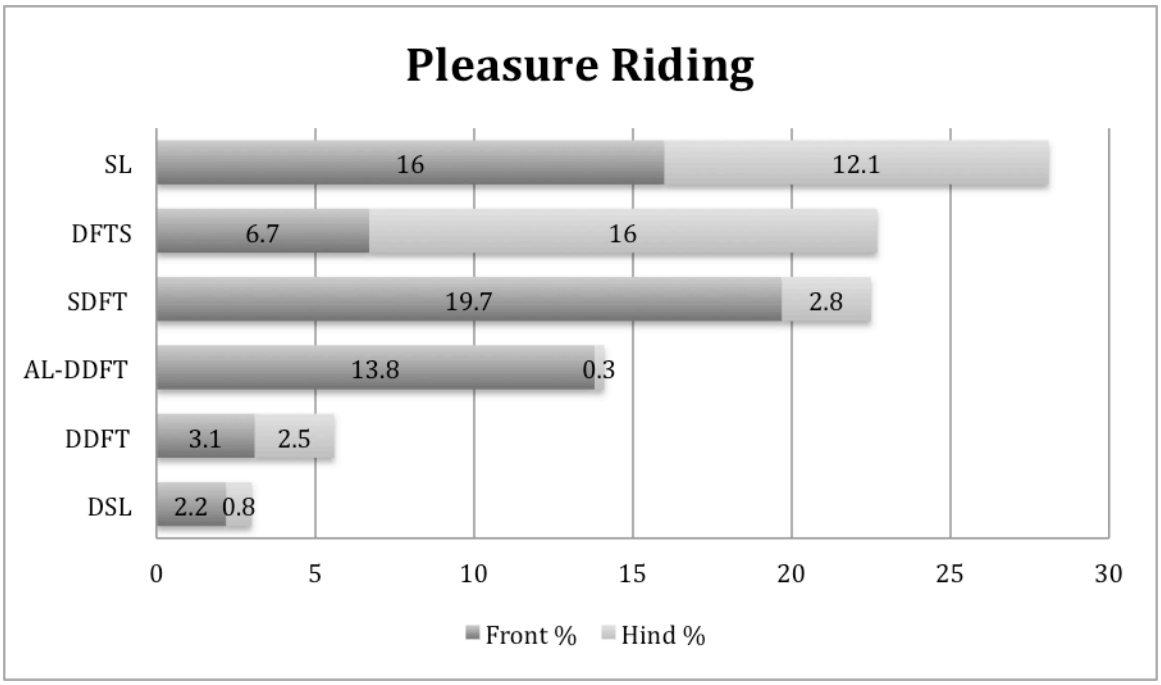

Fig. 1: Distribution of tendon and ligament injuries between forelimbs and hindlimbs (%) of pleasure horses; n=356

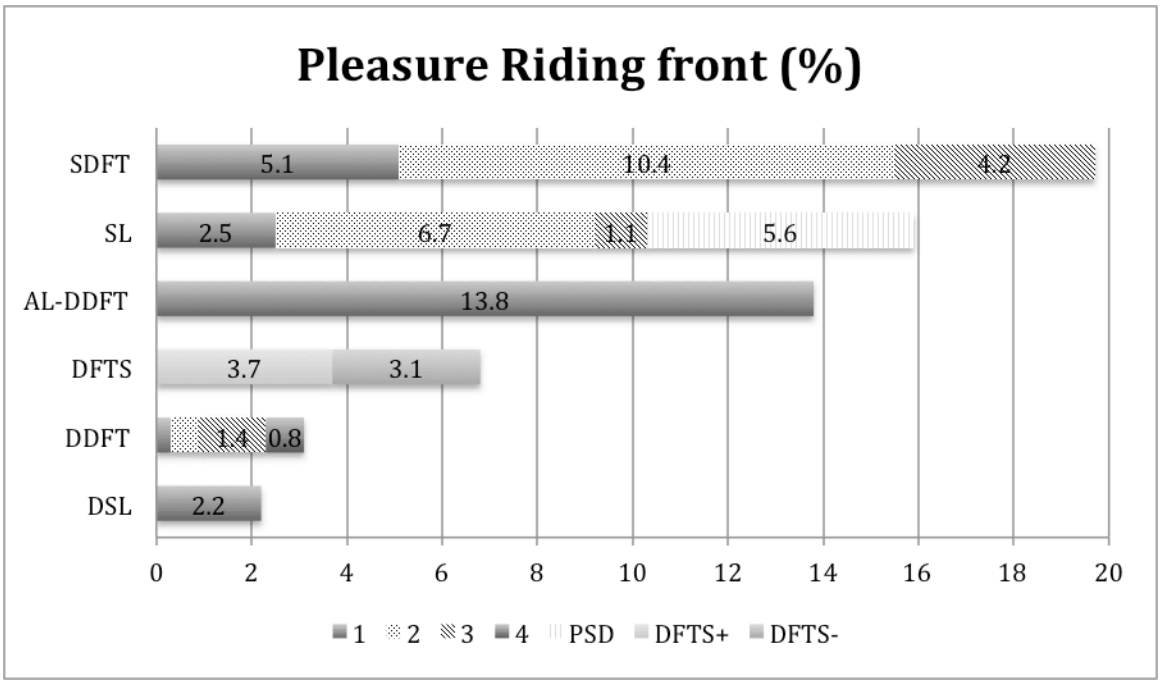

Fig. 2: Distribution of tendon and ligament injuries in the forelimbs (%) of pleasure horses

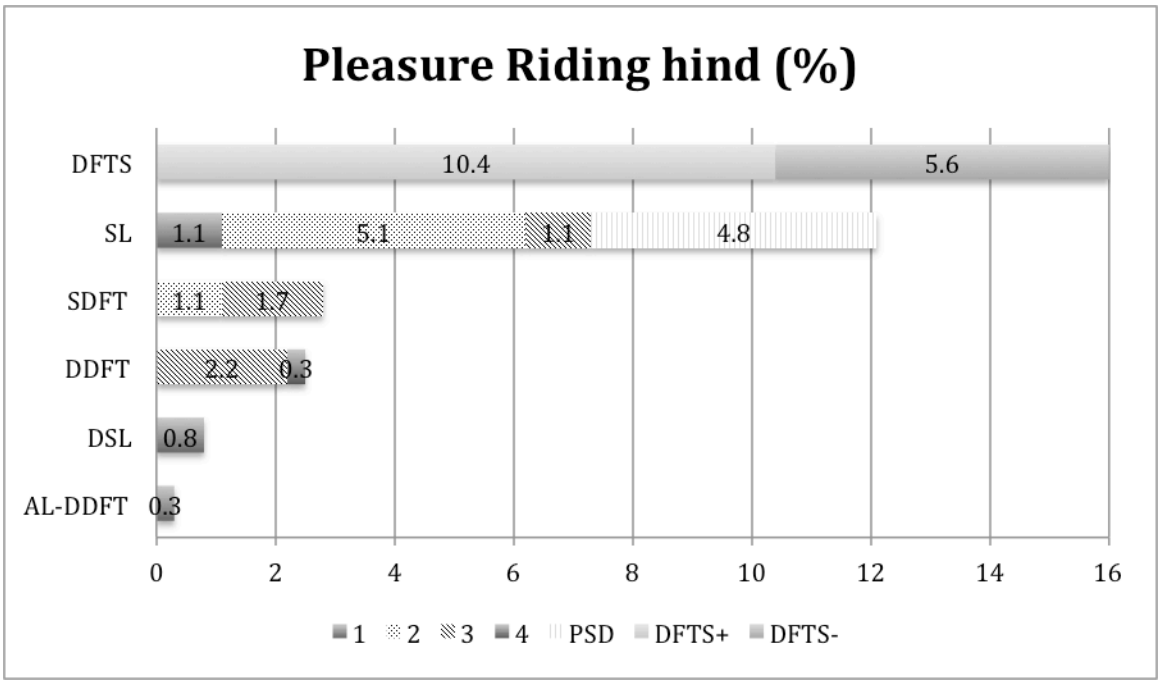

Fig. 3: Distribution of tendon and ligament injuries in the hindlimbs (%) of pleasure horses

7.1.2. Jumping

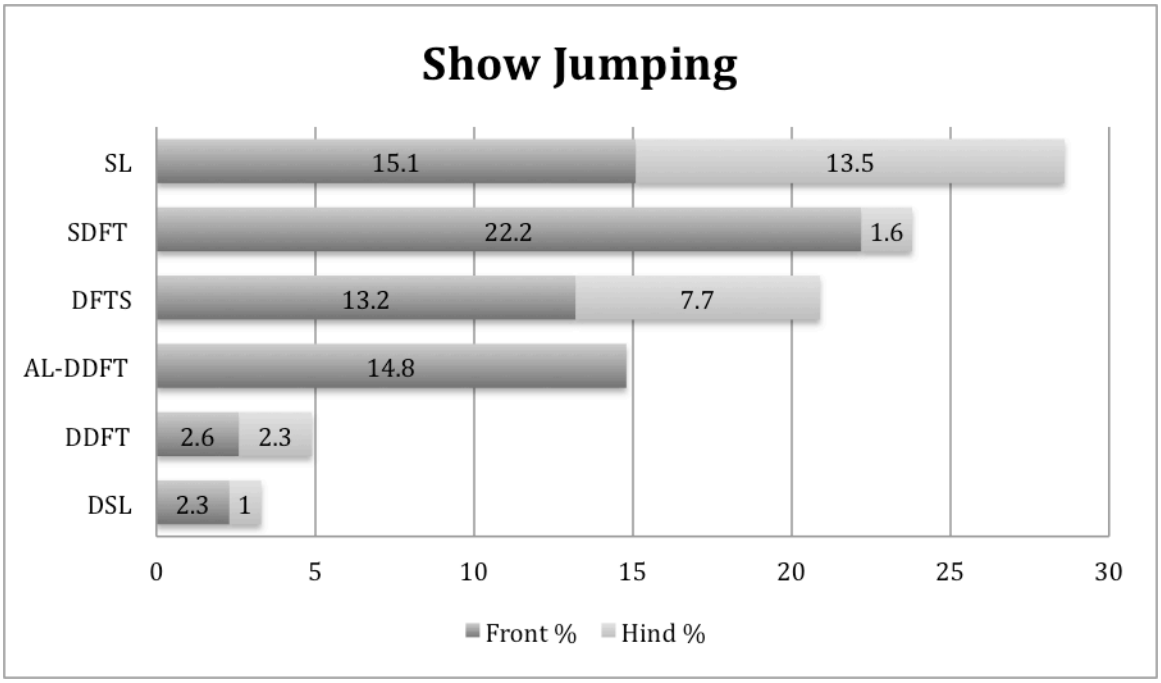

Fig. 4: Distribution of tendon and ligament injuries between frontlimbs and hindlimbs (%) of jumping horses; n=311

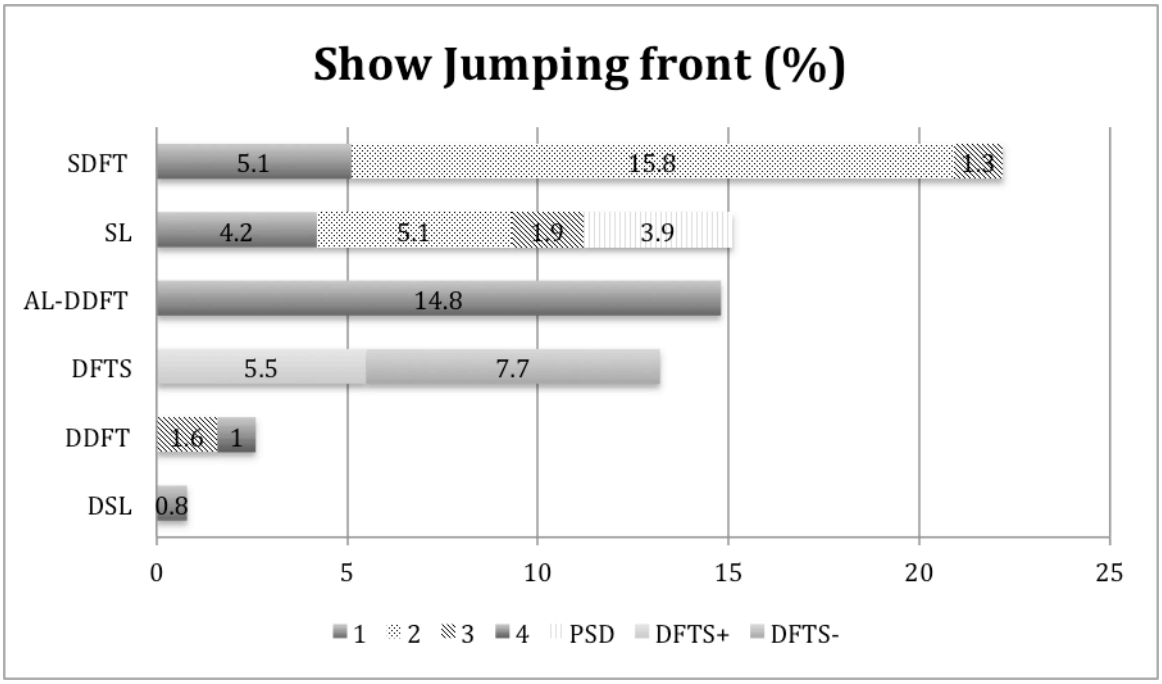

Fig. 5: Distribution of tendon and ligament injuries in the frontlimbs(%) of jumping horses

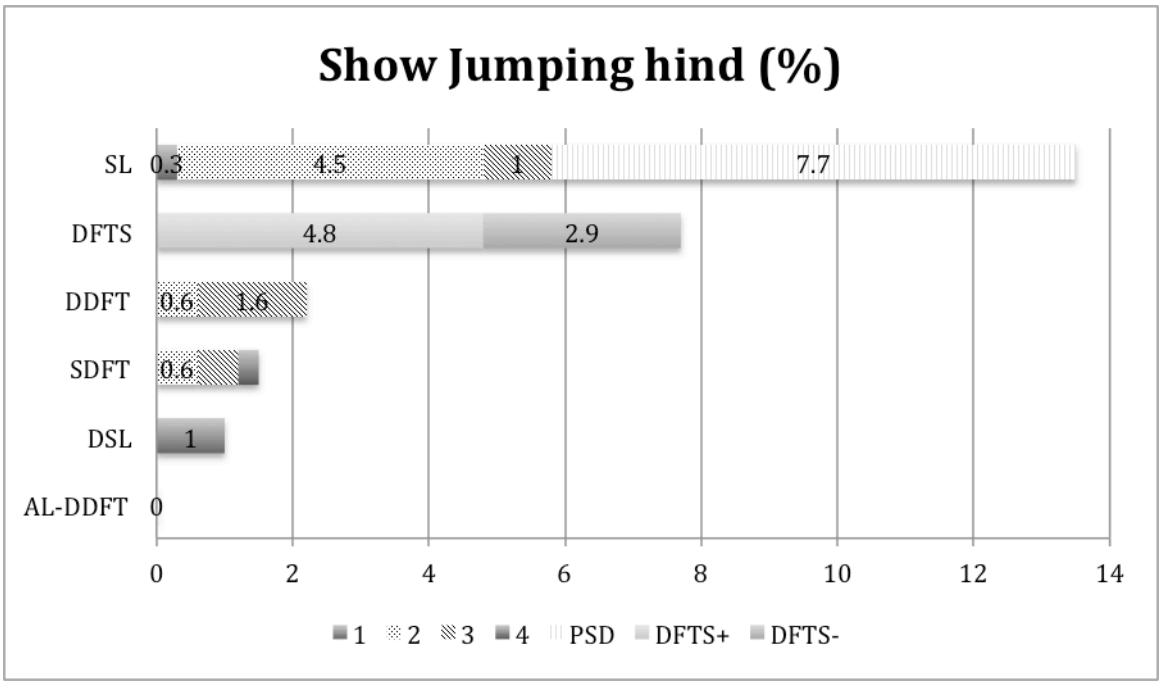

Fig. 6: Distribution of tendon and ligament injuries in the hindlimbs (%) of jumping horses

7.1.3. Dressage

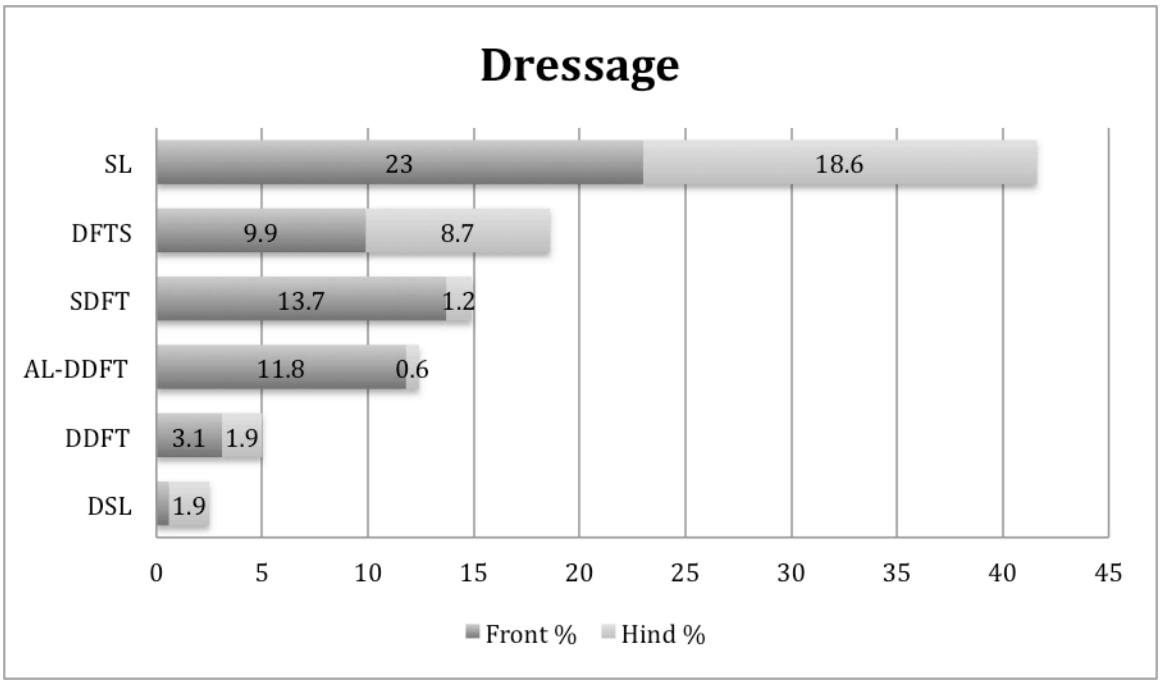

Fig. 7: Distribution of tendon and ligament injuries between forelimbs and hindlimbs (%) of dressage horses; n=161

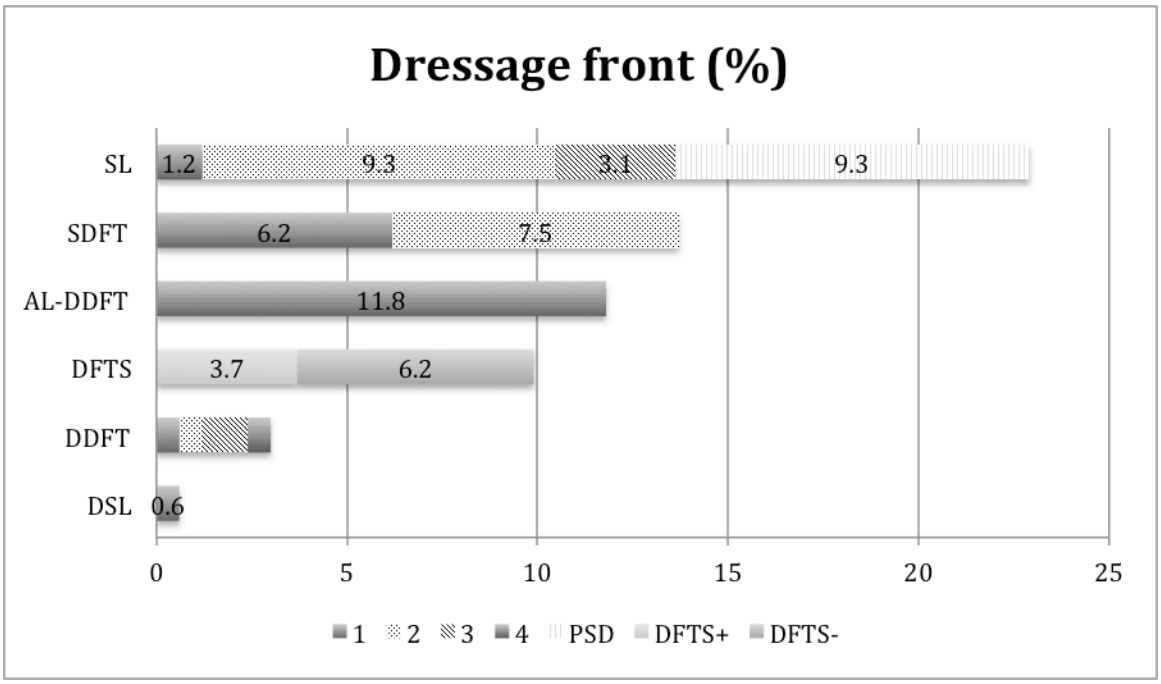

Fig. 8: Distribution of tendon and ligament injuries in the forelimbs (%) of dressage horses

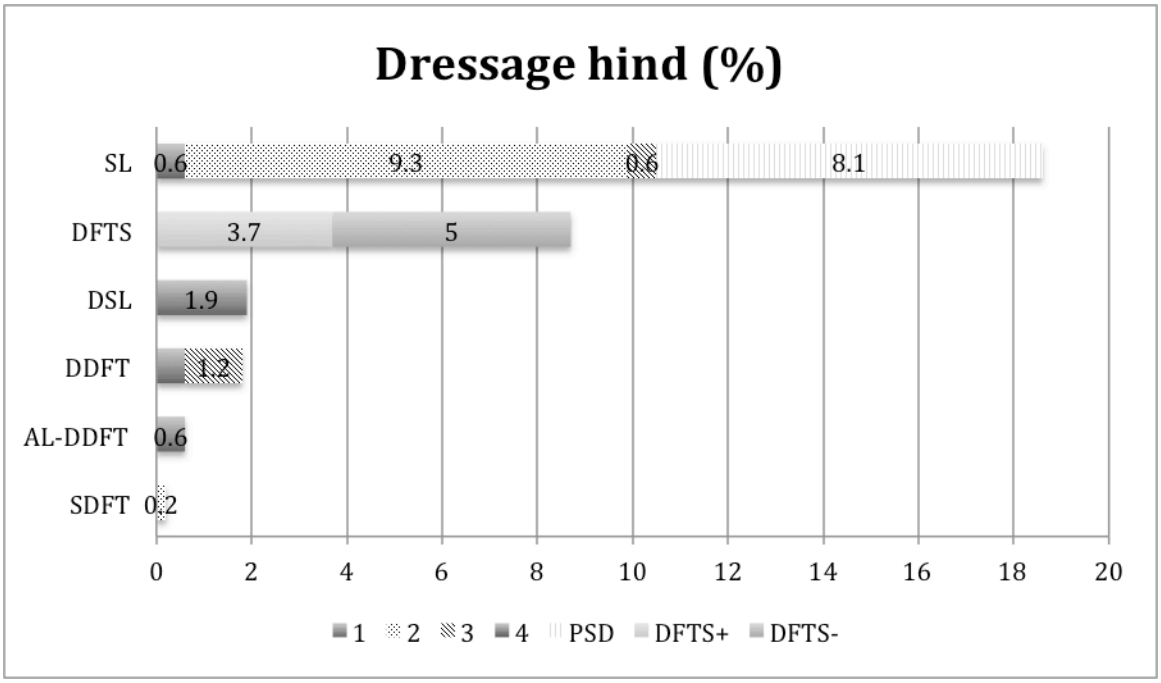

Fig. 9: Distribution of tendon and ligament injuries in the hindlimbs (%) of dressage horses

7.1.4. Eventing

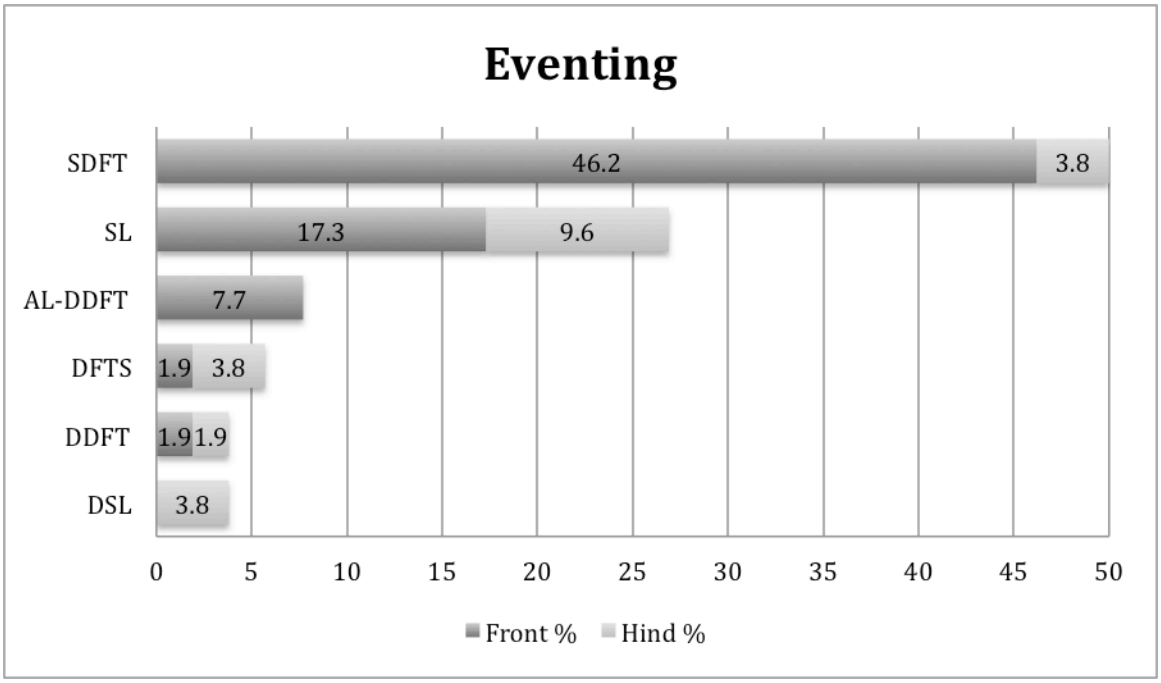

Fig. 10: Distribution of tendon and ligament injuries between forelimbs and hindlimbs (%) of eventing horses; n=52

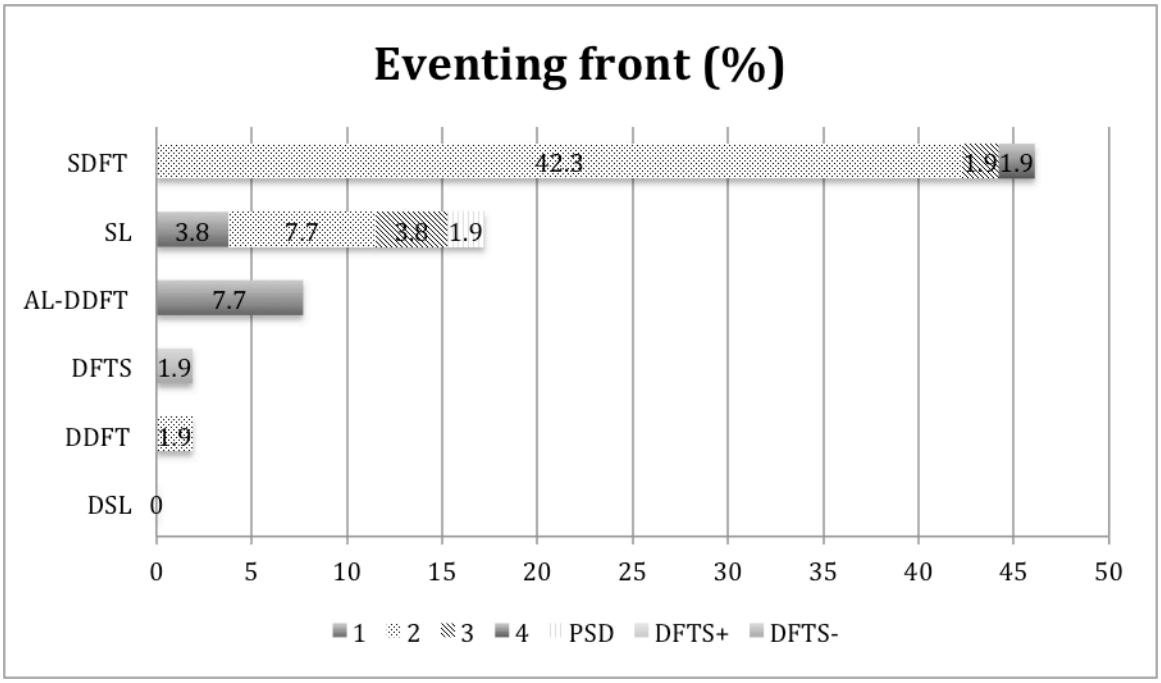

Fig. 11: Distribution of tendon and ligament injuries in the forelimbs (%) of eventing horses

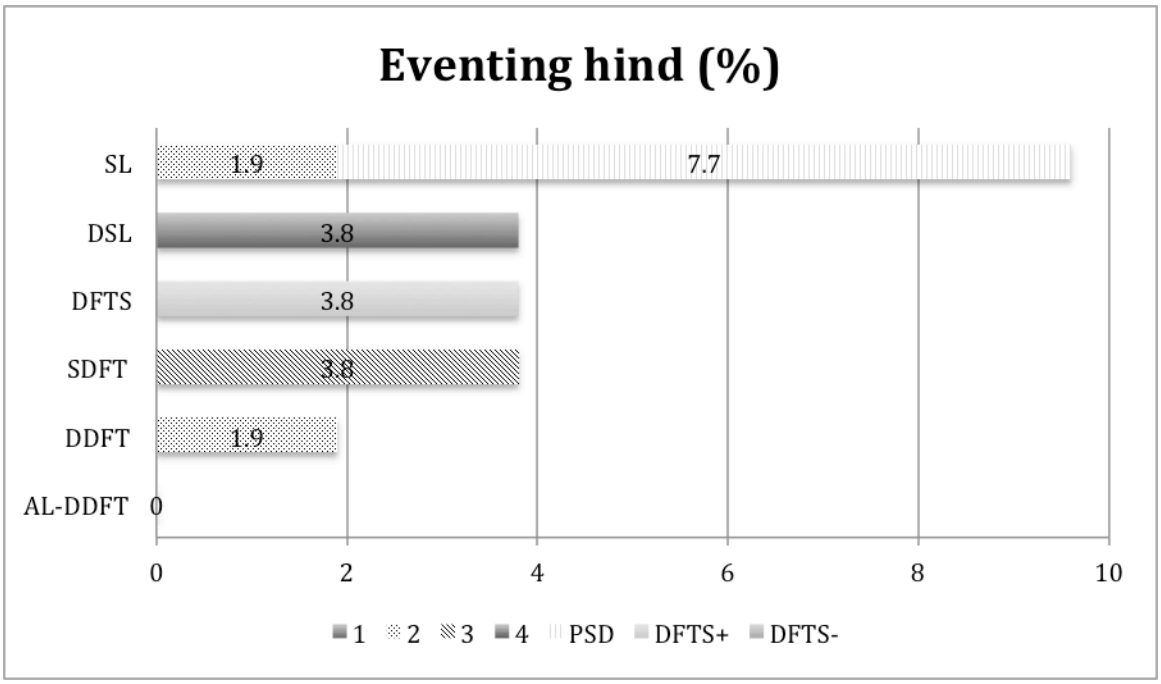

Fig. 12: Distribution of tendon and ligament injuries in the hindlimbs (%) of eventing horses

7.1.5. Driving

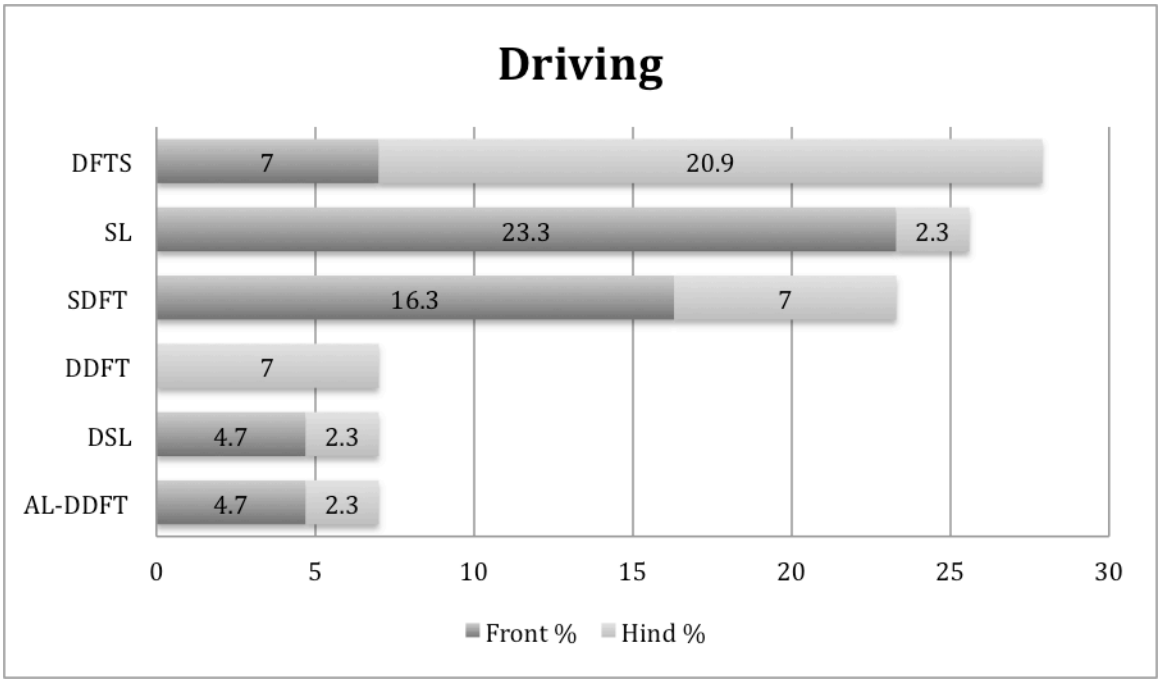

Fig. 13: Distribution of tendon and ligament injuries between forelimbs and hindlimbs (%) of driving horses; n=43

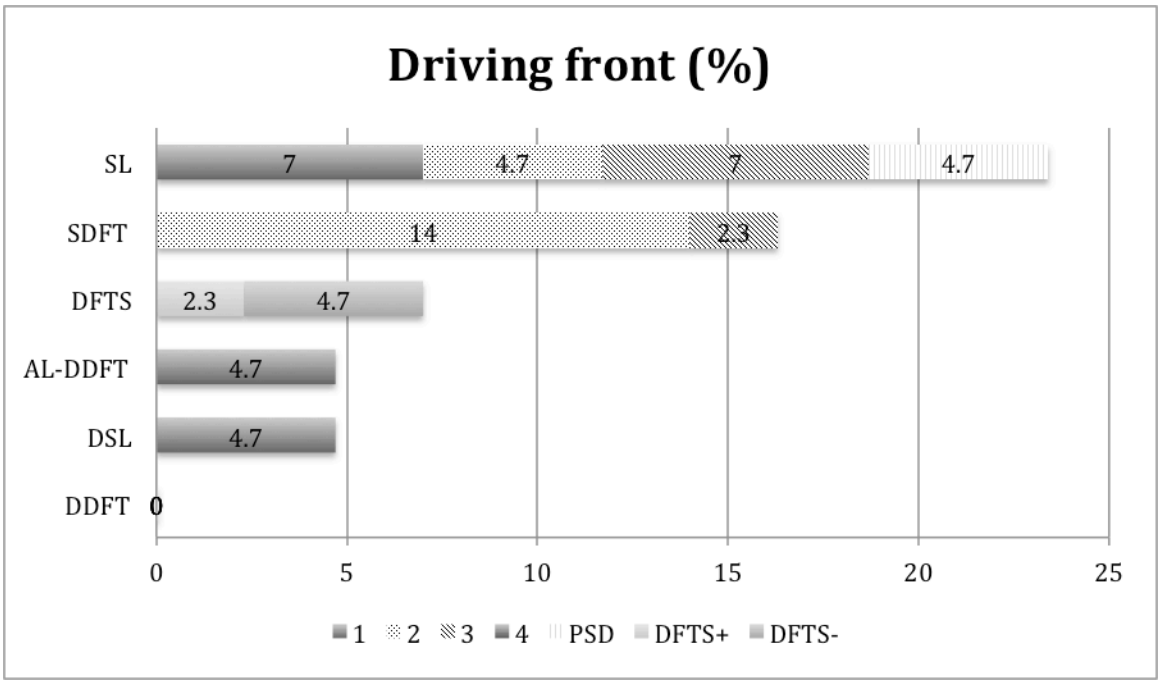

Fig. 14: Distribution of tendon and ligament injuries in the forelimbs (%) of driving horses

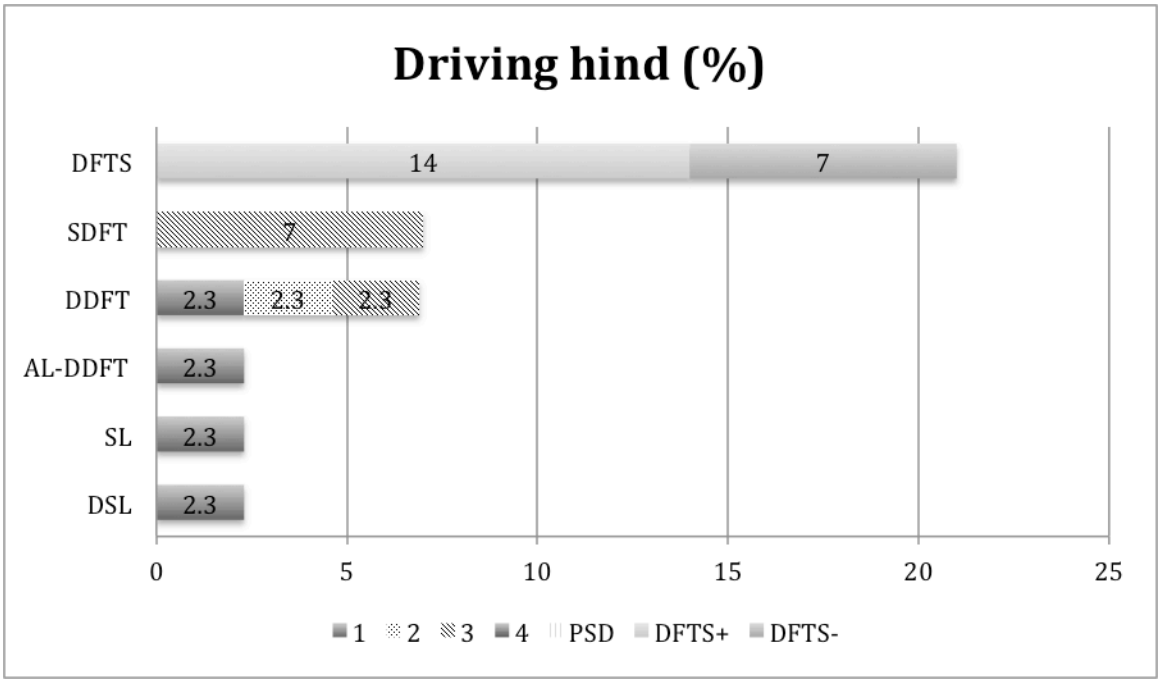

Fig. 15: Distribution of tendon and ligament injuries in the hindlimbs (%) of driving horses

7.1.6. Endurance

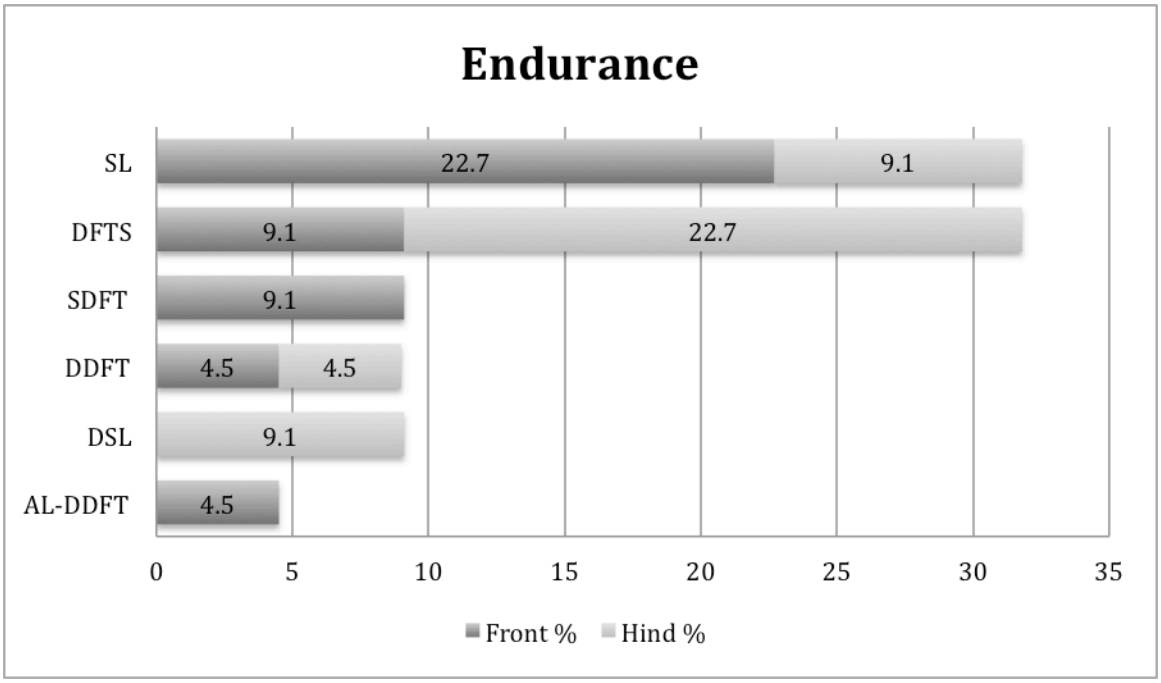

Fig. 16: Distribution of tendon and ligament injuries between forelimbs and hindlimbs (%) of endurance horses; n=22

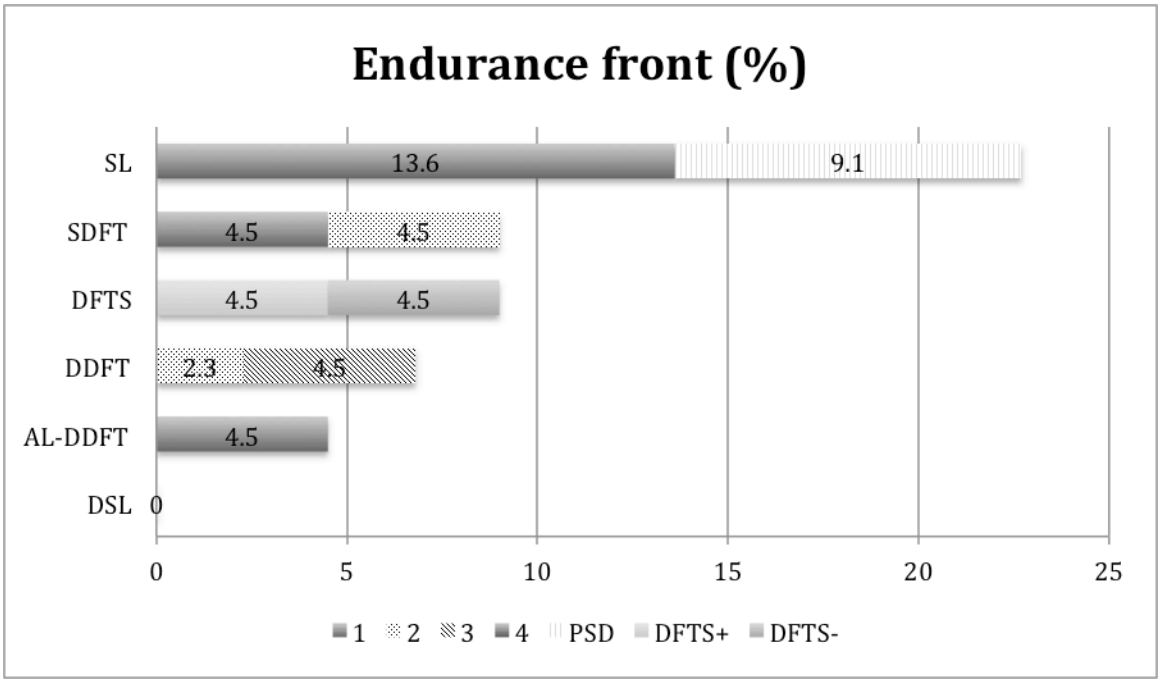

Fig. 17: Distribution of tendon and ligament injuries in the forelimbs (%) of endurance horses

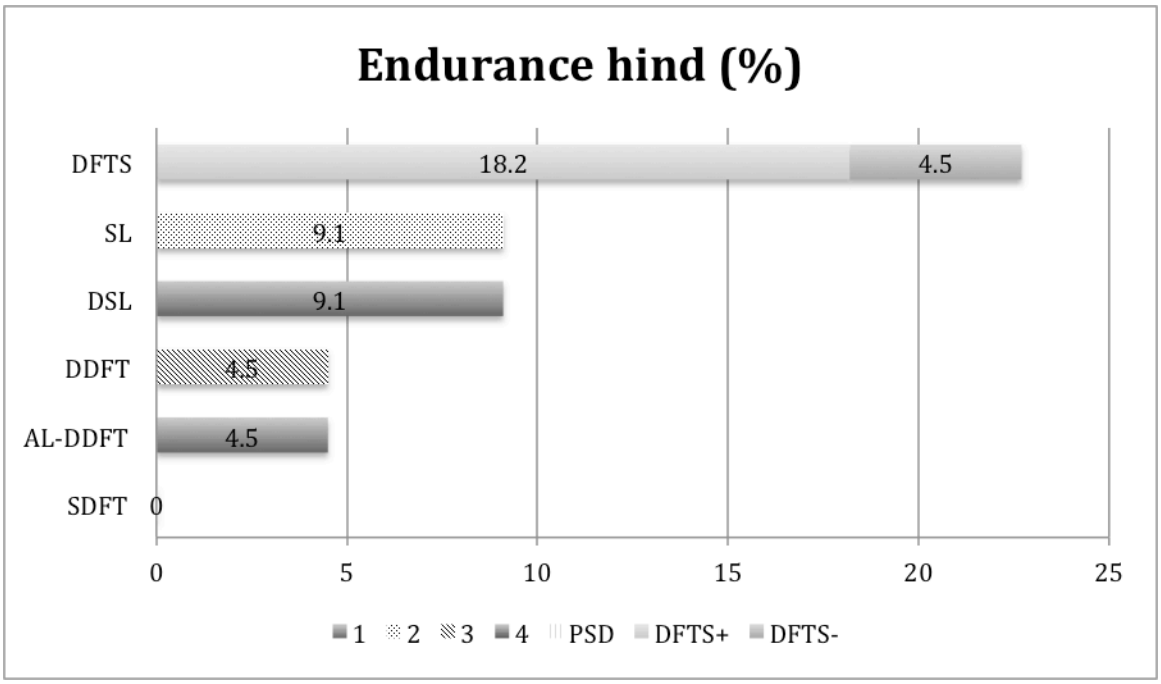

Fig. 18: Distribution of tendon and ligament injuries in the hindlimbs (%) of endurance horses

7.2. Tables

Table 1: Distribution of breed and gender in comparison to the type of use; IH=Icelandic horses; n=horses

Type of use	Pleasure Riding	Show Jumping	Dressage	Eventing	Driving	Endurance	Other	Total
Total (n)	356	311	161	52	43	22	150	1527
Breed								
Warmblood:	181	293	143	37	27	3	28	1046
Ponies / IH:	79	8	3	0	4	1	25	151
Thoroughbred:	13	6	1	10	0	0	53	94
Standardbred:	3	0	0	0	0	0	20	23
Arabian:	24	1	4	5	1	14	4	71
Cold-blood:	25	1	0	0	9	2	3	50
Others:	31	2	10	0	2	2	17	92
Gender								
Mares:	162	110	23	17	12	5	60	542
Geldings:	184	188	115	34	28	10	70	888
Stallions:	10	13	23	0	3	7	18	94
Unknown:	0	0	0	1	0	0	2	3

Table 2: Distribution of the location of injury in comparison to the type of use; Group "Unknown" and "Other" not shown; PAL=palmar/plantar annular ligament; F = forelimbs, H = hindlimbs, T = Total (fore- and hindlimbs)

Type of use	Pleasure Riding			Show Jumping			Dressage			Eventing			Driving			Endurance			Total		
	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T	F	H	T
Total	224	132	356	225	86	311	103	58	161	39	13	52	25	18	43	12	10	22	1009	518	1527
SDFT	70	10	80	69	5	74	22	2	24	24	2	26	7	3	10	2	0	2	306	33	339
Section 1	18	0	18	16	0	16	10	0	10	0	0	0	0	0	0	1	0	1	60	0	60
Section 2	37	4	41	49	2	51	12	2	14	22	0	22	6	0	6	1	0	1	212	10	222
Section 3	15	6	21	4	2	6	0	0	0	1	2	3	1	3	4	0	0	0	31	22	53
Section 4	0	0	0	0	1	1	0	0	0	1	0	1	0	0	0	0	0	0	3	1	4
DDFT	11	9	20	8	7	15	5	3	8	1	1	2	0	3	3	1	1	2	45	48	93
Section 1	1	0	1	0	0	0	1	1	2	0	0	0	0	1	1	0	0	0	2	2	4
Section 2	2	0	2	0	2	2	1	0	1	1	1	2	0	1	1	0	0	0	13	6	19
Section 3	5	8	13	5	5	10	2	2	4	0	0	0	0	1	1	1	1	2	18	38	56
Section 4	3	1	4	3	0	3	1	0	1	0	0	0	0	0	0	0	0	0	12	2	14
AL-DDFT	49	1	50	46	0	0	19	1	20	4	0	4	2	1	3	1	0	1	188	3	191
SL	57	43	100	47	42	89	37	30	67	9	5	14	10	1	11	5	2	7	271	205	476
PSD	20	17	37	12	24	36	15	13	28	1	4	5	2	0	2	2	0	2	89	96	185
Section 1	9	4	13	13	1	14	2	1	3	2	0	2	3	1	4	3	0	3	59	9	68
Section 2	24	18	42	16	14	30	15	15	30	4	1	5	2	0	2	0	2	2	95	84	179
Section 3	4	4	8	6	3	9	5	1	6	2	0	2	3	0	3	0	0	0	28	16	44
DFTS	24	57	81	41	24	65	16	14	30	1	2	3	3	9	12	2	5	7	134	167	301
With PAL	13	37	50	17	15	32	6	6	12	0	2	2	1	6	7	1	4	5	61	106	167
Without PAL	11	20	31	24	9	33	10	8	18	1	0	1	2	3	5	1	1	2	73	61	134
DSL	8	3	11	7	3	10	1	3	4	0	2	2	2	1	3	0	2	2	30	18	48
OTHER	5	9	14	7	5	12	3	5	8	0	1	1	1	0	1	1	0	1	35	44	79
• B. brachii tendonitis	2	-	2	2	-	2	0	-	0	0	-	0	0	-	0	0	-	0	10	0	10
• CS tenovagin.	1	-	1	4	-	4	3	-	3	0	-	0	1	-	1	1	-	1	14	0	14
• TS tenovagin.	-	2	2	-	2	2	-	1	1	-	0	0	-	0	0	-	0	0	-	8	8
• Gastrocn. tendonitis	-	0	0	-	1	1	-	0	0	-	0	0	-	0	0	-	0	0	1	0	1
• Ext. tendon injury	1	2	3	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	6	6	12
• Peroneus tert. tendon	-	2	2	-	0	0	-	1	1	-	0	0	-	0	0	-	0	0	0	16	16
• Prim. PAL	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	4	2	6
• lat/med dig. flex.tend. and tib. caud. tend.	-	3	3	-	2	2	-	2	2	-	1	1	-	0	0	-	0	0	0	12	12

Table 3: Distribution of age in comparison to the location of the injury and the type of use; Group "Unknown" not shown; PAL=palmar/plantar annular ligament; Av = Average; Med = Median

Type of use	Pleasure Riding	Show Jumping	Dressage	Eventing	Driving	Endurance	Total
	Age (years) Av (Med)	Age (years) Av (Med)	Age (years) Av (Med)	Age (years) Av (Med)	Age (years) Av (Med)	Age (years) Av (Med)	Age (years) Av (Med)
Total	13.4 (13.0)	11.1 (11.0)	11.3 (12.0)	11.5 (11.0)	12.4 (12.00)	11.8 (13.0)	11.7 (11.0)
SDFT	15.9 (16.0)	11.5 (12.0)	13.0 (13.0)	12.0 (11.0)	13.9 (15.00)	14.0 (14.0)	12.5 (12.0)
Section 1	19.6 (19.0)	14.0 (15.0)	15.9 (16.0)	-	-	16.0 (16.0)	17.2 (17.0)
Section 2	15.1 (16.0)	10.8 (11.0)	10.9 (10.0)	11.8 (11.0)	13.7 (14.00)	12.0 (12.0)	11.1 (10.0)
Section 3	14.2 (14.0)	11.5 (12.0)	-	12.3 (14.0)	14.3 (15.00)	-	13.0 (13.0)
Section 4	-	10.0 (10.0)	-	17.0 (17.0)	-	-	11.0 (10.0)
DDFT	11.8 (12.0)	10.2 (10.0)	10.3 (10.0)	9.5 (10.0)	9.3 (9.00)	12.0 (12.0)	10.9 (11.0)
Section 1	14.0 (14.0)	-	5.5 (6.0)	-	7.0 (7.00)	-	8.0 (7.0)
Section 2	8.0 (8.0)	7.0 (7.0)	8.0 (8.0)	9.5 (10.0)	12.0 (12.00)	-	10.7 (11.0)
Section 3	12.0 (12.0)	10.2 (11.0)	11.5 (12.0)	-	9.0 (9.00)	12.0 (12.0)	11.1 (11.0)
Section 4	12.5 (14.0)	12.3 (10.0)	17.0 (17.0)	-	-	-	11.1 (11.0)
AL-DDFT	14.6 (14.0)	12.7 (13.0)	12.3 (13.0)	10.0 (10.0)	14.00 (15.00)	7.0 (7.0)	13.1 (13.0)
SL	11.9 (12.0)	10.0 (10.0)	10.9 (12.0)	10.2 (10.0)	11.6 (9.00)	11.9 (13.0)	10.9 (11.0)
PSD	11.0 (11.0)	9.1 (8.0)	10.6 (11.0)	10.8 (10.0)	12.0 (12.00)	13.0 (13.0)	10.4 (10.0)
Section 1	13.5 (14.0)	10.8 (11.0)	10.7 (12.0)	10.0 (10.0)	7.0 (6.50)	8.7 (9.0)	10.7 (11.0)
Section 2	11.7 (12.0)	10.8 (11.0)	11.4 (13.0)	10.2 (10.0)	18.0 (18.00)	15.5 (16.0)	11.5 (11.0)
Section 3	14.9 (13.0)	9.2 (9.0)	9.5 (9.0)	9.0 (9.0)	13.0 (12.00)	-	10.6 (10.0)
DFTS	13.4 (13.0)	11.8 (11.0)	11.4 (12.0)	16.3 (16.0)	11.7 (12.00)	12.4 (14.0)	12.4 (12.0)
With PAL	14.0 (14.0)	11.6 (11.0)	12.3 (12.0)	17.5 (18.0)	12.3 (13.00)	15.0 (15.0)	13.0 (13.0)
Without PAL	12.4 (12.0)	11.9 (11.0)	10.8 (11.0)	14.0 (14.0)	10.8 (10.67)	6.0 (6.0)	11.7 (12.0)
DSL	12.8 (14.0)	9.9 (10.0)	12.5 (13.0)	10.5 (11.0)	12.7 (12.00)	10.5 (11.0)	10.7 (10.0)

7.3. Abbreviations

AL-DDFT Accessory ligament of the deep digital flexor tendon
CS Carpal sheath
DDFT Deep digital flexor tendon
- Section 1 At the level of the tarsal sheath
- Section 2 Between the tarsal sheath and the digital flexor tendon sheath
- Section 3 Within the digital flexor tendon sheath
- Section 4 Deep digital flexor tendon lesions distal to the digital flexor tendon sheath

DFTS Digital flexor tendon sheath
DSL Distal sesamoidean ligament
PAL-D Palmar/ plantar annular ligament desmitis
PSD Proximal suspensory desmitis
SDFT Superficial digital flexor tendon
- Section 1 At the level of the carpal sheath
- Section 2 Between the carpal sheath and the digital flexor tendon sheath
- Section 3 Within the digital flexor tendon sheath
- Section 4 Lesions of the superficial digital flexor tendon branches

SL Suspensory ligament
- Section 1 Body of the suspensory ligament
- Section 2 Lateral and medial branches of the suspensory ligament
- Section 3 Insertion of the branches at the proximal sesamoidean bones

TS Tarsal sheaths

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Curriculum Vitae

Name:	Marc Trump
Date of Birth:	26.08.1981
City:	Düren, Germany
Nationality:	Germany
School Education:	06/1993 - 06/2001: Gymnasium Zitadelle Jülich 06/1989 - 06/1993: Primary School
Highest Graduation:	06/2001 Graduation Diploma (Abitur)
Academic Studies:	10/2004 - 01/2008: Justus-Liebig University, Giessen, Germany 09/2002 - 07/2004: Szent Istvan University, Budapest, Hungary
Approbation:	15.01.2008: Justus-Liebig University, Giessen, Germany
Thesis:	09/2009 - 12/2013 Supervision: Dr. Felix Theiss, Prof. Dr. Anton Fürst Department: Equine Department, Vetsuisse Faculty, University of Zürich
Employment:	06/2008 - 10/2008: Hagyard Equine Medical Institute, Lexington, USA 11/2008 - today: Equine Department, Vetsuisse Faculty, University of Zürich